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Forest Service

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# Geology Report

## Black Butte Watershed

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**Lake County, CA**

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# Table of Contents

# Executive Summary

## Methodology

### *Overview of Methodology*

Previous geologic investigations were reviewed, as were historical air photos and other types of remote sensing imagery. Mendocino National Forest GIS coverages for bedrock and geomorphology were were queried to determine the area occupied by various land types, such as landslides. Field reconnaissance was conducted in various parts of the watershed to verify GIS layers, and to examine some of the outstandingly remarkable geologic values.

### *Analysis Indicators*

The analysis indicators included the levels of road stormproofing,, fuel treatment, and inventory of caves and other geologic values which were likely to occur under the two alternatives analyzed.

### *Spatial and Temporal Context*

Spatial bounding is the watershed boundary since geomorphic processes interact in that realm. The temporal boundary short term (ten years) and long term (50 years).

## Affected Environment

The Black Butte watershed is underlain predominantly by metasedimentary and metavolcanic rock of the Franciscan Complex, and landslides occupy about 63% of the area. The landslides have delivered huge boulders to the stream network, and these rocks play an important role in the stream habitat.

## Environmental Consequences

### *No Action Alternative*

#### Direct Effects and Indirect Effects

Since there are no new activities which would occur under this alternative, there would be no new direct effects. However, there would be small indirect effects in that it would be less likely that fuel reduction and road stormproofing projects would be implemented than under the Proposed Action Alternative. The same is true for cave inventories and cave management.

#### Cumulative Effects

The cumulative effects of the No Action Alternative over the next 50 years would result in a higher potential for large stand replacing fires and road related landslides than under the Proposed Action Alternative. The No Action alternative would also have less protection for outstanding geologic values since inventories would be less likely to occur

### *Summary of Effects*

There would be no changes in management approach and current environmental trends would continue. The No Action Alternative would not improve watershed health nor conservation of geological values.

### *Proposed Action Alternative*

#### Direct Effects and Indirect Effects

The proposed action would focus projects and inventories (such as fuel reduction, road storm proofing, landslide and cave inventories, and geologic research) to meet the intent of the Wild and Scenic Rivers Act. Such activities would lower the potential for large high severity fires, and road related landslides. Similarly they would enhance the conservation of geologic values as inventories are a prerequisite for resource management. The Black Butte Wild and Scenic River capacity study showed no expectation that human uses due to designation would affect the geologic ORVs unless recreational cave exploration occurs. As the Black Butte Wild and Scenic River capacity analysis recommends, the Strategic Management Approaches includes a provision to consider writing and implementing cave management plans to mitigate impacts.

#### Cumulative Effects

The cumulative effects of the proposed action Alternative in the Black Butte River watershed over the next 50 years would result in lower potential for large stand replacing fires and road related landslides than under no action. Management related sediment delivered to the Black Butte River may measurably decrease under the proposed action. No significant cumulative impacts to caves are expected with the proposed action and if impacts do begin to occur, there would be consideration of writing and implementing cave management plans.

### *Summary of Effects*

The proposed action would result in a positive change in watershed health and conservation of geological values.

### *Compliance with law, regulation, policy, and the Forest Plan*

The alternatives being proposed meet law, regulation, policy and the Mendocino National Forest Plan Land and Resource Management Plan. Other laws relevant to geologic values are the. Federal Cave Resource Protection Act of 1988, and the Paleontological Resources Preservation Act of 2009.

# Geology Report

## Introduction

This report analyzes geologic hazards and resources as they pertain to the No Action and Proposed Action alternatives within the Black Butte River watershed, with focus on the Wild Scenic River Corridor.

## Proposed Actions and Alternatives Analyzed

For a description of the proposed action, see Chapter 2 of the Black Butte River Watershed Assessment.

## Methodology

### *Detailed Methodology*

Previous geologic investigations were reviewed, as were historical air photos and other types of remote sensing imagery. Mendocino National Forest GIS coverages for bedrock and geomorphology were were queried to determine the area occupied by various land types, such as landslides. Field reconnaissance was conducted in various parts of the watershed to verify GIS layers, and to examine some of the outstandingly remarkable geologic values.

### *Analysis Indicators*

Three indicators are used to gage conservation of Geologic values and landslide potential These are:

1. Level of vegetation management activities which would reduce the likelihood of stand replacing fire;
2. Level of stormproofing activities on roads which would reduce the likelihood of road related landslides.
3. Level of inventory for caves or other Outstandingly Remarkable Geologic Values.

### *Spatial and Temporal Bounding of Analysis Area*

Spatial bounding is the watershed boundary since geomorphic processes interact in that realm. The temporal boundary short term (ten years) and long term (50 years).

## Affected Environment

Geologic Setting and Outstandingly Remarkable Geologic Values

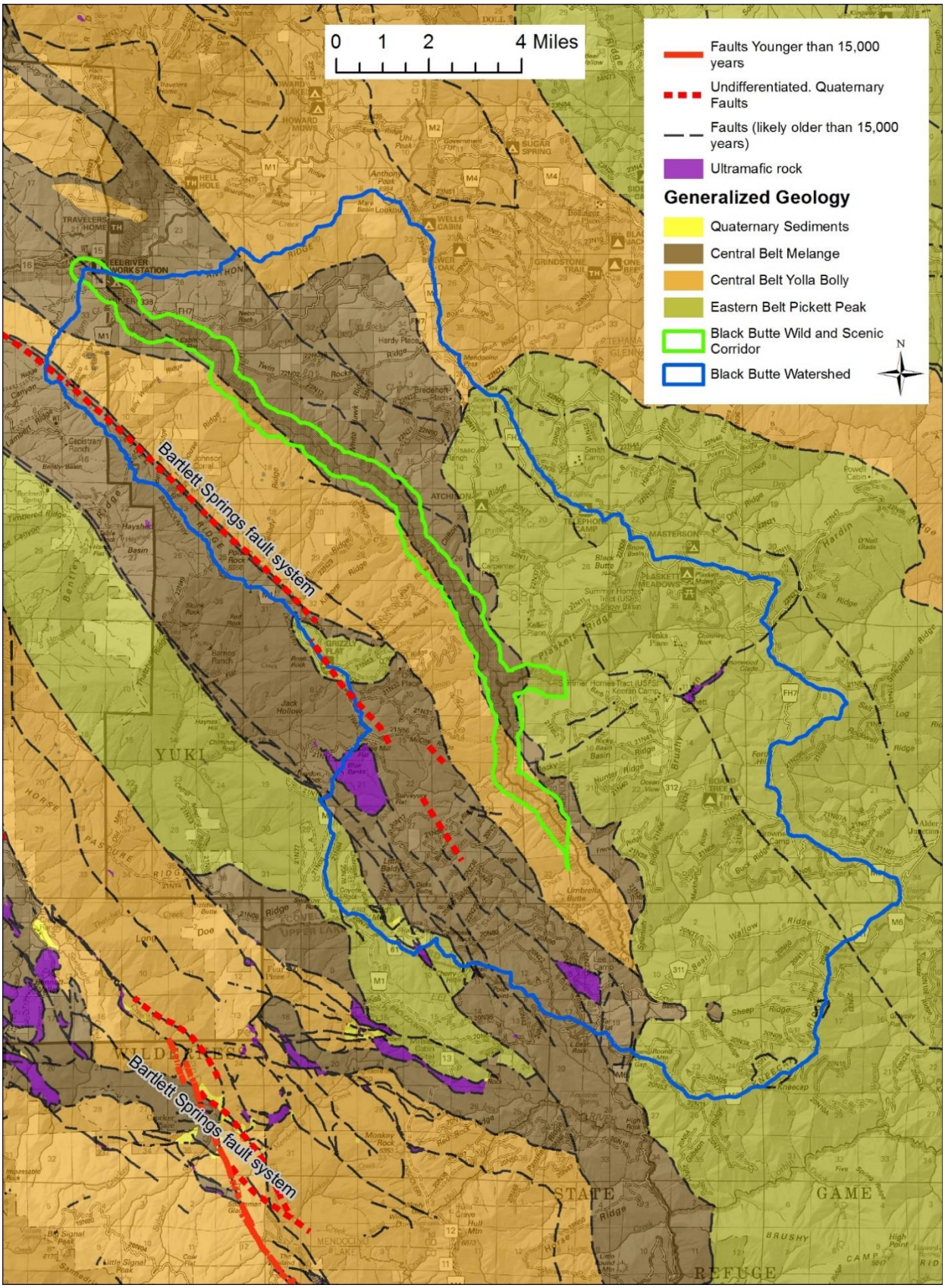
The Black Butte watershed occupies about 103,594 acres, and it contains a total of about 436 miles of road. The Wild and Scenic corridor occupies about 6,579 acres and it contains a total of about 12 miles of road. This watershed is a textbook example of a tectonically active landscape where most of the landforms were created by large landslides. The Black Butte River cuts through weak, altered and deformed marine sedimentary rocks of the Central Belt of the Franciscan Complex and around massive rock blocks of greenstone and greywacke. Incision of the river gorge set the stage for the formation of massive landslides which extend all the way from the drainage divide down to the river. Landslides facilitate the delivery of large woody debris, sediment and impressively large, stream-altering boulders. These factors have likely forced fish and other animals to adapt in order to exist in a rapidly developing river system with unique, geologically-defined habitat. In addition, unique talus and tension crack caves within

Butte Creek and Cold Creek watersheds are the direct result of landslide processes. Caves are closely linked to cultural resources and wildlife habitat. The high elevation glacial deposits in the vicinity of Black Butte Mountain are landslide prone where slopes are steep, and are important for groundwater storage. Groundwater helps maintain summer flows into Black Butte River. For these reasons, geologic features and characteristics in the Black Butte Watershed constitute Outstandingly Remarkable Values that directly control watershed function. These values are listed below, and described in more detail in subsequent sections.

1. Large Deep-Seated Landslides-
2. Prominent Rock Knobs-
3. Glacial Features-
4. Caves-
5. Invertebrate Fossils-
6. Waterfalls-
7. Plate Boundary Observatory-

**Bedrock-**
The Black Butte River watershed contains a variety of metamorphosed sedimentary and volcanic rocks, including metagraywacke (a type of sandstone), quartz mica schist, argillite matrix tectonic mélange and metabasalt. These are part of the Jurassic and Cretaceous Franciscan Complex (Central and Eastern Belts), and many of these rock units are landslide prone. From NE to SW, the rock bands underlying the watershed include: a) Eastern Belt Franciscan with a minor amount of ultramafic rock; b) Central Belt mélange (along the river corridor); c) Central Belt Yolla Bolly terrane; d) Another band of the Central Belt Melange (including serpentinite); and e) Eastern Belt Pickett Peak terrane, Valentine Spring Formation (Map 1).

**Mineral Resource Potential-**
An investigation by the US Geological Survey and the U.S. Bureau of Mines revealed no significant mineral resource potential in the Black Butte Watershed (USGS 1983). They found no mines, but did mention some prospecting for copper at Black Butte, but nothing was developed. The potential for oil and gas was also found to be very low.



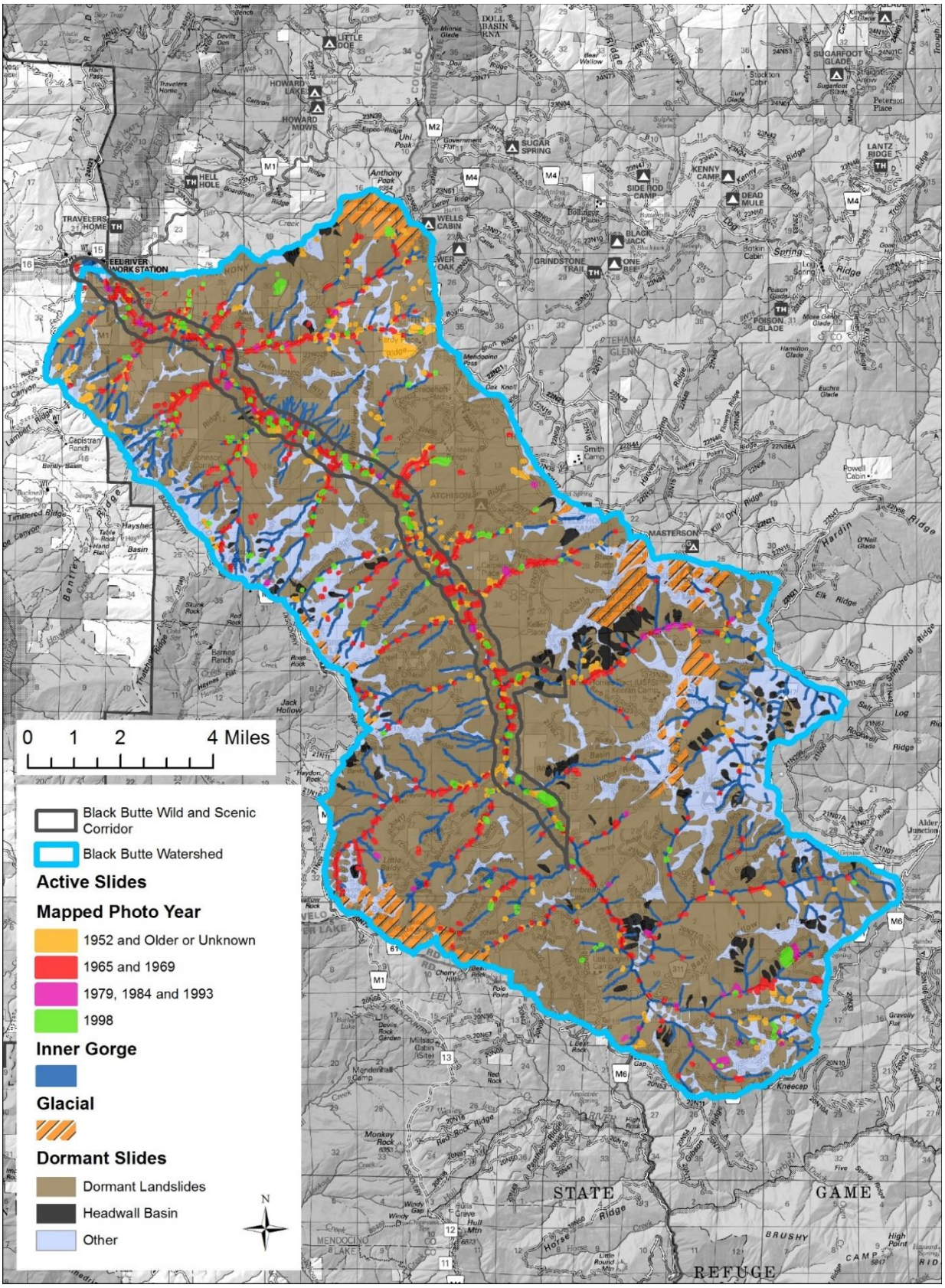

**Map 1:** Bedrock

**Geomorphology-**

**Dormant Landslides-** Large dormant landslides occupy about 80% of the watershed (Map 2). The existence of these features is attributable to a combination of weak rock, high precipitation, rapid uplift, and seismic shaking. These landslides produce hummocky terrain with closed basins which often collect water and form meadows, ponds or lakes such as Keller Lake. Parts of these landslide deposits are active and deliver large volumes of sediment to the river. Earthflows in Blue Slides Creek and elsewhere have remained continuously active over the past 60 years or longer and are characterized by grass covered glades with scattered trees, dissected by streams with raw inner gorges. Many of the large earthflows deliver large rocks, up to 50 feet in diameter directly into the river, forming unique fish habitat as well as shallow caves. Some of the landslides develop amphitheater-shaped head scarps, and tension cracks and fissures in the rock above the scarp form small caves. Dormant landslides are subject to reactivation during particularly wet winters, seismic events, undercutting by streams or human activities, or when vegetation is removed.

**Glacial Features-** Glacial landforms have been identified in the area around Black Butte/Plaskett Meadows and also in the Anthony Peak area (Davis 1958). A small glacial moraine forms the dam on the lake at Plaskett meadows. This dam has been raised to increase the size of the lake.

**Black Butte-** Black Butte is a prominent mountain which lies along the NE margin of the watershed near the crest of Plaskett Ridge about two miles west of Plaskett Meadows. It displays good examples of a variety of interesting geomorphic features. The hollow on the NE flank is most likely a small glacial cirque. Black Butte is underlain by two rock units, and both are part of the Eastern Belt Franciscan. These units are the Chinquapin metabasalt (part of the Pickett Peak Terrane, South Fork Mountain Schist), and the other is an undifferentiated quartz mica schist rock unit which surrounds the Chinquapin metabasalt. Black Butte is noteworthy because it displays evidence of glacial erosion on the NE flank, and also of massive landsliding off the SW flank, where collapse of the bedrock sent debris downslope, and in the process formed a closed basin now occupied Keller Lake.




**Map 2:** Geomorphology

**Geologic Resources-**

Geologic resources are described below.

**Caves-** Caves occur in a variety of settings across the watershed, including landslide fissures in bedrock, in talus at the base of landslide scarps and other types of bluffs, and along the river between huge boulders delivered there by landslides. These caves provide habitat for a variety of flora and fauna, and if large enough, could have been used by humans for shelter or other purposes. There are historical accounts of human use of such caves along Black Butte River: "There is a story about Lloyd Barrass (owned McIsaac's from late 20s to 1950) was out bear hunting with his hounds down on the Black Butte River. His hounds sniffed out some outlaw-looking characters living in a cave on the river. Arthur Carpenter was bringing them food and supplies while they were hiding out. Covelo was well known as a haven for folks hiding from the law, probably still is. Arthur had a reputation for having contacts with some questionable characters and always had a .44 in his belt in the small of his back. Chris". From Chris Baldo, personal communication to Hilda Kwan 8-1-17. A cave inventory has not been conducted in the Black Butte watershed.

**Waterfalls-** A waterfall in lower Cold Creek was visited in the field, and is about 12 feet high. It is a very scenic landscape feature, and may be a barrier to anadromous fish..

**Prominent Rock Knobs-** Prominent rock knobs occur across the landscape and range from a few hundred feet to more than 1000 feet in diameter, with nearly vertical margins up to several hundred feet high. In some areas within the Franciscan Complex, they are referred to as "knockers". These blocks consist of erosion resistant bedrock of various types, and examples include Nebo Rock and Twin Rocks. They form a unique part of the ecosystem, particularly where they contain caves and likely have cultural significance.

**Invertebrate Fossils-** Invertebrate fossils have been identified along the River near its junction with Nebo Creek. They are characterized as megafossils, but have not been identified, and are likely mollusks of the variety Buccia

In addition to the Outstandingly Remarkable geologic values described above, other important geologic resources include

**Rock Aggregate-** Rock aggregate and rip rap is used for road surfacing and erosion mitigation. However it should be noted that Prescription #10 in the LRMP Standards and Guidelines directs that no rock be removed from the Wild and Scenic River Corridor.

**Geologic Special Interest Areas-** There are no designated Geological Special Interest Areas in the watershed, though some would most likely qualify and could be identified when the Land and Resource Management Plan is revised.

**Groundwater-** Groundwater is a valuable resource, and is known to support unique ecosystems within the watershed as well as provide the water for summer flows in the river. Groundwater is also utilized at some Forest Service facilities in the watershed.

**Plate Boundary Observatory-** Though not a geological resource per se, the Earth Scope Project has a high resolution GPS installation in the Black Butte watershed which is part of the Plate Boundary Observatory. This project is sponsored by the National Aeronautics and Space Administration (NASA) the National Science Foundation (NSF), and UNAVCO, and it collects data for analyzing seismic and volcanic activity in the Pacific Northwest. UNAVCO is a non-profit university-governed consortium that facilitates geoscience research and education using Geodesy, which is the science of accurately measuring and understanding the Earth's geometric shape, orientation in space, and gravity field.

**Geologic Hazards-**

**Landslides-** Landslides are probably the most pervasive and consequential of the geologic hazards in the watershed. Landslides dominate the sediment regime, and routinely damage roads and structures.

**Naturally Occurring Asbestos-** Natural asbestos is likely present in the ultramafic rock within the watershed, but this has not been verified by inventory or laboratory testing. The distribution of ultramafic rock is shown on Map 1.

**Seismic Hazards-** The Black Butte River watershed is subject to ground shaking from several sources, including the San Andreas fault system and the Bartlett Springs Fault zone, which generally parallels Elk Creek to the SW of Black Butte River. It was reported that the San Francisco earthquake of 1906 triggered large landslides in the Eel River Watershed (California Department of Water Resources, 1970). More recently, a magnitude 3.8 earthquake was recorded just west of Lake Pillsbury on the Bartlett Springs Fault system (https://earthquake.usgs.gov/earthquakes/eventpage/nc72532161#executive
Seismic ground shaking in the Black Butte watershed is a very important factor in the way large landslides behave over time. Map 1 displays active the active fault traces of the Bartlett Springs fault system.

## TOTAL MAXIMUM DAILY LOADS (TMDL)

The Forest Service conducted a landslide inventory for the Black Butte River watershed as part of the TMDL process for the Middle Fork Eel River. Historical air photos were examined over the time period from1940 to 2002 and landslides were classified according to type, age,

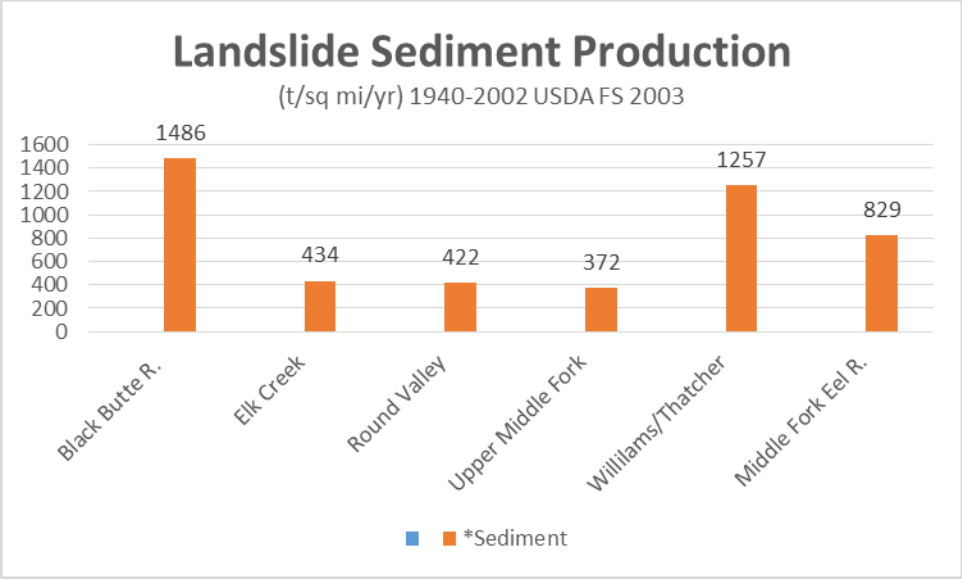



**Figure 1:** Landslide Sediment Production 1940-2002 (USDA FS 2003)

Management-association, and sub-watershed. The active landslides mapped in this process are concentrated along stream courses and the resulting pattern is evident on Map 2.
It was also found that the proportion of the volume which was management related for the Middle Fork Eel River from 1940-2002 was about 6% (USDA FS 2003). The age of each landslide is indicated by a color scheme identified in the legend on Map 2.

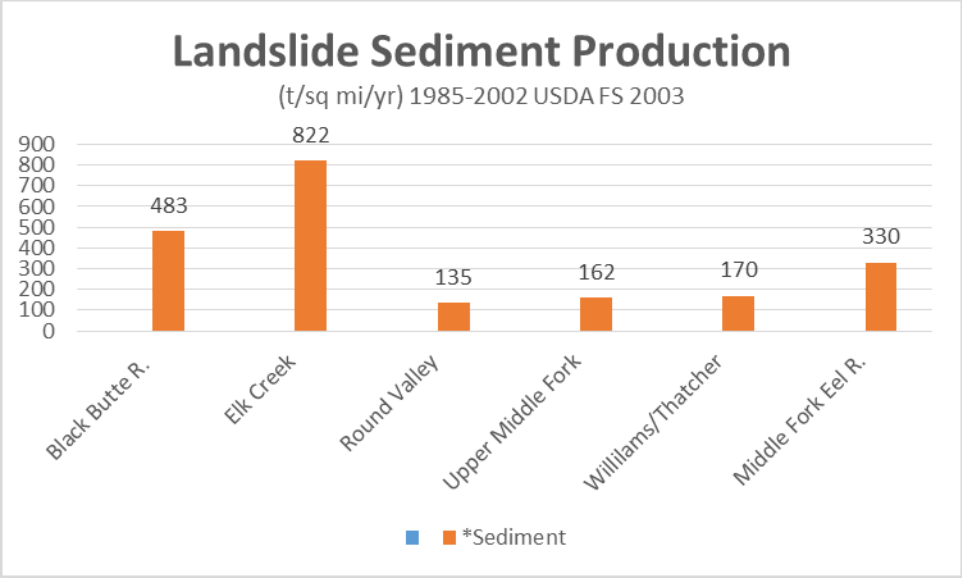



**Figure 2:** Landslide Sediment Production 1985-2002 (USDA FS 2003)

It is noteworthy that the landslide production rate in units of tons per square mile per year varies considerably in different time periods. Figure 1 below displays landslide production for the entire period analyzed, which was 1940-2002. In this time period, Black Butte River had the

highest rate of all the subbasins analyzed (1,486 t/sq mi/yr). Figure 2 shows the rate for the time period 1985 to 2002, and Black Butte River was second highest of the subbasins analyzed (483 t/sq mi/yr). This is the time period used by US EPA in determining the current total sediment loading, and Black Butte River was determined to be 740 t/sq mi/yr (Figure 3). The current loading for the entire Middle Fork Eel basin was 656 t/sq mi/yr, and of that, 324 was natural landslides, road/harvest landslides was 6 t/sq mi/yr, totaling 330 for landslides (USEPA 2003, Page 39). This figure is reflected below on Figure 2 as the sediment production value for Middle Fork Eel River.
The sediment TMDL Allocation for Black Butte River is 740 tons/sq mi, and this equals the total current sediment loading value (Figure 3).

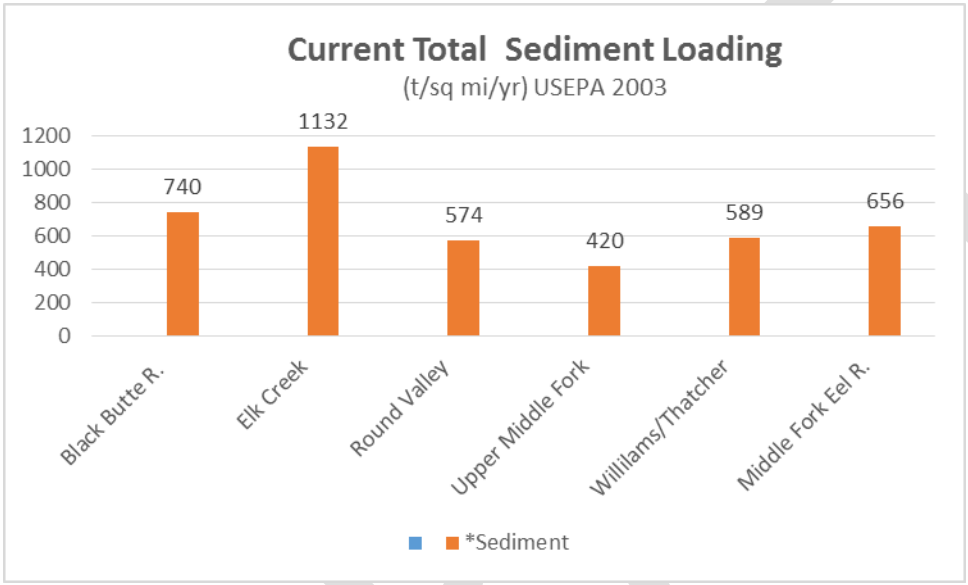
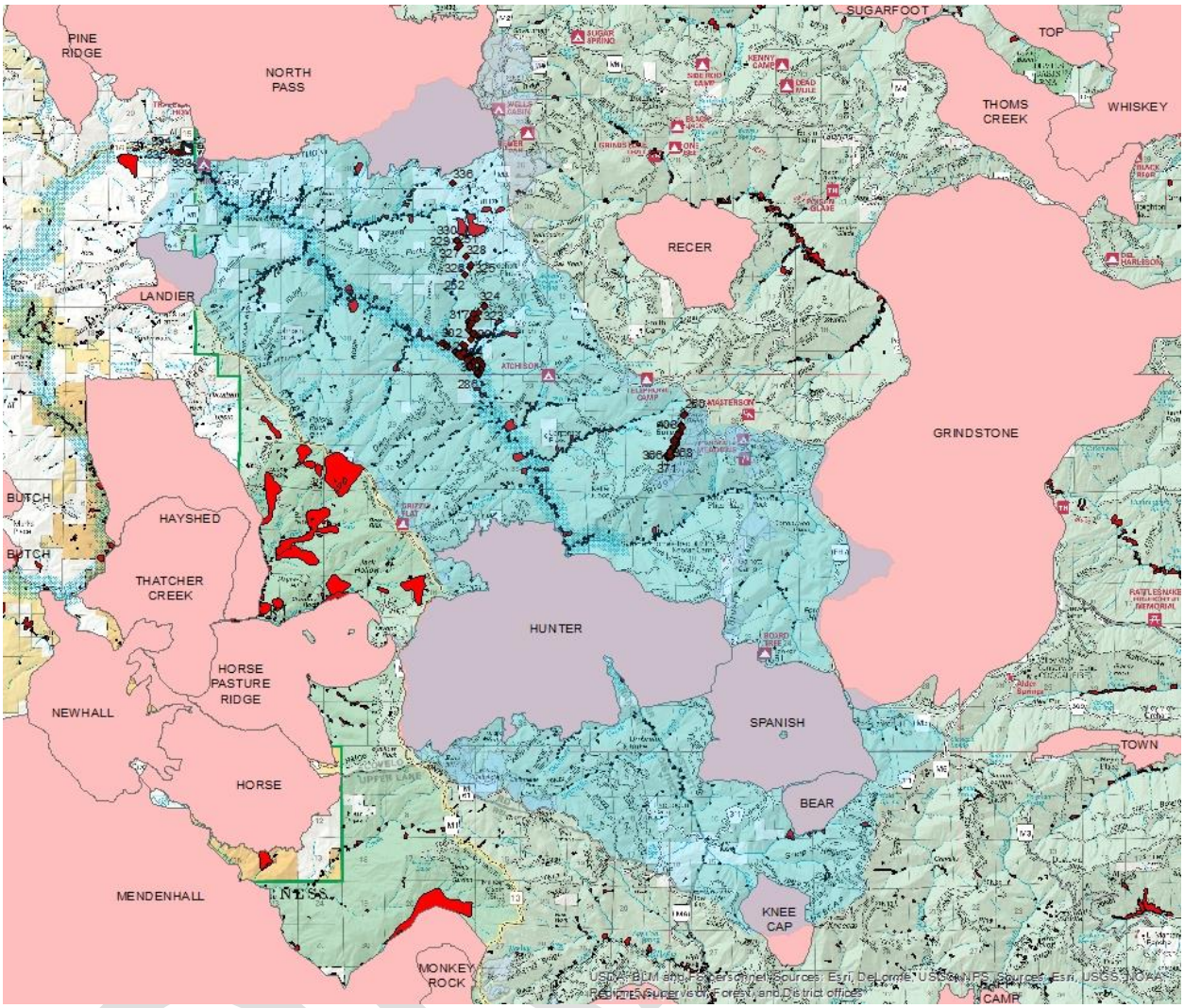



**Figure 3:** Total Current Sediment Loading (US EPA 2003 Page 40)

**Fire History**
The fire history is described in the Fire and Fuels Report and it reveals that the largest historic fires in the watershed occurred in the headwaters, the Hunter and Spanish Fires (Map 3 and see also the Fuels Report). These events are important because removal of vegetation typically increases landslide rate. Following the Hunter Fire, The Forest (Bob Faust) obtained color IR air photos for the fire, plus a single flight down the river corridor to Eel River station at a scale of 1:24,000. The goal of this project was to identify the effects of the heavy precipitation which occurred in the winter of 2005-2006. It should be noted that the fire occurred **after** the high precipitation winter of 2005-2006 and as a result had no effect on landslides which occurred that winter. It was found that the effects of that winter were small relative to previous flood years (1997, 1983, 1964, and1955) and only 5 new landslides were identified. In addition, 68 previously mapped slides showed evidence of movement.




**Map 4:** Historic fires in Black Butte Watershed

## Strategic Management Approaches

Strategic management approaches have been created to help further direct standard and guidelines to achieve purposes of the Act.

- Management activities outside of the designated corridor but within the 5th field Black Butte Watershed (HUC 1801010401) should consider effects to the Wild and Scenic River corridor (Section 10 of Act).
- Designation neither prohibits development nor gives the federal government control over private property. Acquisition of lands within the Wild and Scenic corridor will have to follow those rules set forth in section 6 of the Wild and Scenic Rivers Act.
- New range improvement structures should not be authorized unless they provide additional protection of river values.

- Fish habitat improvement projects and structures that do not adversely affect the free-flowing condition of the river would be allowed, following a Section 7 (WSRA) determination.
- Caves will be protected in accordance with the Federal Cave Resource Protection act of 1988, and regulations under Forest Service Title 36 CFR 290. If cave resources are impacted by visitation, consider writing and implementing cave management plans.
- System Roads will be stormproofed with highest priorities first, as funding becomes available.

## Inventory and Monitoring

Inventory for caves and unique geologic areas is encouraged in the Proposed Action, as is monitoring of landslide movement. Monitoring could be efficiently accomplished by using satellite imagery, InSAR, and LiDAR. Monitoring would be initiated after landslide producing precipitation events. This would assist in road repairs and prioritizing roads for storm proofing.

## Environmental Consequences

*No Action Alternative*

### Direct Effects and Indirect Effects

Direct effects: Since there are no new activities which would occur under this alternative, there would be no new direct effects. However, there would be small indirect effects in that it would be less likely that fuel reduction projects would be implemented. The same is true for road stormproofing activities,cave inventories and cave management.

### Cumulative Effects

The cumulative effects of the No Action Alternative over the next 50 years would result in a higher potential for large stand replacing fires and road related landslides than under the Proposed Action Alternative. This is due to the likelihood of less fuel treatment and road stormproofing. No significant cumulative impacts to caves are expected with the proposed action and if impacts do begin to occur, there would be consideration of writing and implementing cave management plans. The No Action alternative would have less protection for outstanding geologic values since inventories would be less likely to occur.

### Summary of Effects

Under the No Action alternative, there would be no changes in management approach and environmental trends would continue.

*Proposed Action Alternative*

### Direct Effects and Indirect Effects

The proposed action would focus projects and inventories (such as fuel reduction, road storm proofing, landslide and cave inventories, and geologic research) to meet the intent of the Wild and Scenic Rivers Act. Such activities would lower the potential for large high severity fires, and road related landslides. Similarly they would enhance the conservation of geologic values as inventories are a prerequisite for resource management. The Black Butte Wild and Scenic River capacity study showed no expectation that human uses due to designation would affect the geologic ORVs unless recreational cave exploration occurs. As the Black Butte Wild and Scenic River capacity analysis recommends, the Strategic Management Approaches includes a provision to consider writing and implementing cave management plans to mitigate impacts.

### Cumulative Effects

The cumulative effects of the proposed action Alternative in the Black Butte River watershed over the next 50 years would result in lower potential for large stand replacing fires and road related landslides. This is relative to the no action alternative, and is due to the likelihood of more fuel treatment and road stormproofing. Similarly, the proposed alternative would improve the level of protection for outstanding geologic values to inventory work which would better identify these values in the field. Management related sediment delivered to the Black Butte River may measurably decrease under the proposed action. No significant cumulative impacts to caves are expected with the proposed action and if impacts do begin to occur, there would be consideration of writing and implementing cave management plans.

### Summary of Effects

The proposed action would result in a positive change in watershed health and conservation of geological outstandingly remarkable values.

Table 2-4 Comparison of Effects of Alternatives by Resource

| | No Action Alternative | Proposed Action Alternative | |
|---|---|---|---|
| Geology | The potential for damage to geologic values and to watershed function would be higher than under the Proposed Action Alternative. This is because it does not promote inventory of caves, road stormproofing or fuel treatments. | This alternative is more likely to conserve geologic outstandingly remarkable values by fostering inventory and monitoring. It also promotes fuel treatments and road stormproofing, which would reduce the potential for road related landslides and for large high severity fires. | |

*Compliance with law, regulation, policy, and the Forest Plan*

- Caves are protected by the Federal Cave Resource Protection Act of 1988 and regulations under Forest Service Title 36 CFR 290
- Paleontological resources are protected by the Paleontological Resources Preservation Act of 2009. On Forest Service lands, paleontological resources are regulated by Forest Service Title 36 Code of Federal Regulations Part 291.
- Both caves and Paleontological Resources are managed according to policy in Forest Service Manual 2880.

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# APPENDIX 1: Standards and Guidelines

## RX#10:

These management directions attempt to balance protection of natural resources with protection of recreational opportunities:

1. Conduct fire management activities to minimize landscape alteration and land disturbance.
2. Pursue acquisition of private lands through exchange or other means.
3. Acquire easements for public access and to prevent degradation of scenic quality, or incompatible private development.
4. Allow no common variety mineral extraction and pursue mineral withdrawal for National Forest lands within the river corridors.
5. Existing use by livestock may be allowed to continue commensurate with protection of wild and scenic river values. No new allotments or permits will be approved.
6. Provide for recreation in a primitive setting which offers considerable physical challenge and requires well developed outdoor skills

    a) Provide inconspicuous facilities (outside Wilderness) where needed for safety and sanitation. b) Permit overnight use of undeveloped areas, establish and enforce occupancy rules as needed. c) Construct or improve trails, and post travel routes as needed to properly disperse recreation use and promote safe travel in the area.
    d) Increase public understanding of the management direction for Wild and Scenic Rivers through the use of brochures, signs, and other media.

7. Permit felling and/or removal of timber outside of Wilderness only where necessary to maintain or enhance user safety and scenic quality, or to prevent insect or disease epidemic.
8. Meet a visual quality objective of retention.
9. Control or prevent erosion that damages scenic quality or endangers water quality or fishery resources. Establish ground cover on denuded areas capable of supporting vegetation.
10. Implement recommendations contained in the Summer Steelhead Management Plan for protecting and improving anadromous fish habitat within the Middle Fork of the Eel River.
11. Coordinate management of the anadromous and resident fisheries resources of the Middle Fork of the Eel River with the California Department of Fish and Game.
12. Address attainment of aquatic conservation strategy objectives when developing Wild & Scenic River management plans. (FSEIS ROD p. C-34)

## Key Watersheds

Since Black Butte watershed was identified as a Key Watershed in the LRMP, the following are Standard and Guidelines also apply, in addition to Prescription 10:

1. Prohibit road construction in remaining unroaded portions of inventoried (RARE II) roadless areas within key watersheds.

2. Reduce existing system and nonsystem road mileage within key watersheds and outside or roadless areas. Road closure with gates or barriers do not qualify as a reduction in road mileage. If funding is insufficient to implement reductions, permit no net increase in amount of roads in key watersheds.

3. Assign key watersheds the highest priority for watershed restoration.

4. Conduct watershed analysis prior to management activities, except minor activities such as those categorically excluded under NEPA with the exception of timber harvesting. Require watershed analysis prior to timber harvesting.

# APPENDIX 2: Aquatic Conservation Strategy Objectives

## AQUATIC CONSERVATION STRATEGY OBJECTIVES

All the alternatives would be consistent with the Aquatic Conservation Strategy Objectives. . The rationale for this determination is as follows:

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.
2. Maintain and restore spatial and temporal connectivity within and between watersheds.
3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.
4. Maintain and restore water quality necessary to support healthy riparian, aquatic and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.
5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.
6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing.
7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.
8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.
9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.